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Original research article

We're the same as the Inuit!: Exploring Australian Aboriginal perceptions of climate change in a multidisciplinary mixed methods study

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ABSTRACT

Significant research attention has been given to understanding the entanglements of culture and climate change in Indigenous communities for global and Australian contexts. Although there is a growing body of knowledge on the threats and vulnerabilities posed by climate change to Indigenous peoples and cultures, there is only modest substantive research on the ways that Australian Aboriginal people in remote, arid-zone communities observe, understand, experience, and act upon the changing climate. This paper emphasises the importance of place-based research methods for understanding local social and cultural processes in a research project which investigated Aboriginal understandings and responses to climate change in the interior, arid Upper Georgina River Basin (UGRB) in North West Queensland, Australia. The study used a multidisciplinary and mixed-method approach, including a modified national climate change survey. Based on this survey methodology, a distinctive geographic and Indigenous focus shaped the study on public risk perceptions, understandings, and responses to climate change. This study recognises the crucial importance of identifying, measuring and documenting important changes and impacts taking place in the human landscape as only this kind of attention will insure that remote regional communities are coping with the environmental stressors and challenges of the Anthropocene.

1. Introduction

As the projected impacts of global anthropogenic climate change will be profound and far-reaching with broad scale and fundamental transformations occurring in many natural environments [1], we specifically ask what the future holds for Aboriginal people in remote arid regions in Australia. It is anticipated that communities in those regions will face very specific challenges, including a higher number of extremely hot days per annum, longer dry spells, increased seasonal deluges and increased flooding. These changes will have significant impacts on both human and ecological systems, as Bardsley and Wiseman ([2]: 715) noted: "people in remote indigenous communities continue to confront extreme environmental conditions such as extreme heat or poor quality water supplies, as well as challenges of the colonial and post-colonial eras, including socio-economic and political marginalization". In this context, questions about the ongoing sustainability of rural and remote communities are being raised. However, despite the increasingly grim predictions of change for inland Australia, and the increasingly harsh conditions endured by its residents, many Aboriginal people do not welcome the prospect of moving away from their communities and their countries as an adaptation strategy (e.g., [3]). In our interviews with Upper Georgina River Basin (UGRB) Aboriginal people (hereafter Georgina people), many expressed the desire to remain on their traditional lands as the primary way of maintaining connection to kin and country. As a result, our attention focused strongly on the kinds of climate change adaptation that would be required to allow Aboriginal people to stay 'on country'.

A number of epistemologically relevant questions need to be resolved in order to engage in research that can inform meaningful and culturally relevant planning for a sustainable future in a changing climate. One such question is how to develop interdisciplinary research that overcomes the problems of silo thinking, on the one hand, and cultural-centrism, on the other. Isolation within boundaries of disciplinary literatures and methodologies can limit the approach to a complex problem such as climate change whereas ways of addressing the problem from different disciplinary perspectives can increase the overall explanatory power of research [4]. A contributing problem is the methodological difficulty of understanding and analysing culture in relation to climate change itself. As Adger et al. ([5]:112) have observed, "methods for studying culture tend to be qualitative, frequently

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including ethnography and participant observation, and data from these methods do not sit comfortably with the quantitative approaches prevalent in other social and natural sciences on climate change". In the study under discussion, the need for a transdisciplinary cross-cultural approach to environmental risk perceptions and understandings was imperative [6,7].

The epistemological issues surrounding disciplinary boundaries and cultural-centrism in climate research also reveal further conceptual difficulties with which this paper is concerned. In particular, this paper engages – methodologically – with the problems posed by *scale*. Scalar thinking has long been at the heart of both climate change research and climate change policy. In the domain of climate research, the 'global' has loomed large in the production of climate science through the dissemination of scientific knowledge through global narratives, and the posing of climate change as a collective action problem that can only be meaningfully resolved at the level of the 'global' [8]. While climate research in the natural and social sciences has long privileged the global, it is becoming increasingly apparent that a better understanding of local knowledges and practices, as well as the political mediation between the local and the global through the (inter)national, is necessary in order to develop a comprehensive understanding of the social impacts of climate change and differentiated capacity for climate change adaptation (see [8–10]).

Possibly due to the emphasis on the global and the national in prevailing epistemological and political schemes, Indigenous issues have been under-represented in climate change reporting and research globally, including lack of engagement with Indigenous knowledge systems [11]. Much research on climate change in first nation contexts has focussed on the physical threats and vulnerabilities posed by climate change on indigenous communities, discussed largely in terms of technological and infrastructure solutions (e.g., [12]), whereas other studies have investigated adaptation responses and how individuals and communities are coping with climate change. More significantly for our study, some research in Australia has identified how the emergent syntheses between understandings of traditional (or indigenous) science and western science can shape people's responses. An examination of Yolngu perspectives in planning adaptation policy in North East Arnhem Land led to a model that relied on Indigenous knowledge, western science and climate change knowledge as well as an assessment of community vulnerability for building community adaptive capacity [13].

There is to date, however, only a modest amount of substantive research on the ways that Aboriginal people in remote, arid-zone communities observe, perceive, experience, and act upon the changing climate, including Bardsley and Wiseman [2] for northern South Australia, and Horne et al. [14] and Race et al. [85] in Central Australia. While the study area is in some ways 'typical' of many more marginal rangeland regions of northern Australia, the extent to which more traditionally-oriented environmental values, beliefs, cultural meaning systems, and assumptive world views currently influence individual and community risk perceptions, understandings, and adaptation responses to climate change can be profoundly different (e.g., [13,15,16]). This paper draws on a research project that contributes to this field of inquiry. The research project [17] had two principal aims. The first was to explore the perceptions, understandings, and responses to media coverage and possible local experiences of perceived climate change of Aboriginal people in the Upper Georgina River Basin (UGRB) which encompasses the border region of North West Queensland and the Northern Territory (NT). An important objective in this phase of the study was to undertake an informed and valid comparison between perceptions of climate change and climate change risks in the UGRB and perceptions in the national Australian context, thereby crossing from a regional to a national scale. While there are inherent challenges with such conventionally understood 'cross-cultural' comparisons, we contend that a mixed-methods approach to this exercise develops a more fine-grained understanding of specific barriers and viable strategies for climate change adaptation and action.

A second aim was to study the adaptive capacity of these communities in the face of the perceived threats of climate change, and to broader environmental impacts, particularly with regard to emergency and disaster management, land and riverine management, housing and settlement adaptation, and enterprise development responses. With this broad range of topics, we attracted a research team from different disciplinary backgrounds (see also Section 4). Drawing on the multidisciplinary expertise, the project aimed to establish baseline data for future longitudinal research about the threat and issue of climate change in the region. As direct experience of climate change seems to be important for people in understanding that extreme weather events are human-caused [18], the documentation of Georgina people's experiences were valuable. This study is one of an increasing number of studies which have addressed the significance and influence of indigenous community members' reported direct encounters with noteworthy environmental changes and events, thought to be consequences of climate change (e.g., [19,20]).

This paper presents an overview of the project findings together with a focus on research methods in order to explore the opportunities and challenges that can arise in the application of mixed-methods in cross-cultural research. We argue that a combination of quantitative and qualitative methods brought deeper understanding of the ways in which Aboriginal communities in the UGRB can use their perceptions and knowledge-based understandings to engage in more meaningful dialogues about climate change. In particular, we argue that despite some limitations (identified in Section 6), the methods bring insights not only about Aboriginal people's knowledge which can include Traditional Ecological Knowledge and other place-based understandings, and different ways of knowing (including storytelling, image-making and art) but also about how this knowledge continues to be a significant component of Georgina people's understandings and perceptions about climate change. In this way, local, culturally based knowledge of the social and ecological environments can help build and maintain social and environmental resilience and hence people's capacity to adapt to a changing environment. Underlying this approach is the fundamental understanding that Aboriginal cosmology relates to the inter-relationship between the human and non-human worlds in which human causes of ecological events are an integral component [21,22]. Although a full discussion of this topic in relation to Indigenous perceptions of climate change is beyond the scope of this paper, we point out that Georgina narratives of climate change were mostly consistent with this worldview.

2. The study region

The Upper Georgina River Basin is an interior, arid-zone region in North West Queensland and adjacent area in the NT (Fig. 1). Today there are five small Aboriginal communities in the UGRB: Alpurrurulam, Camooweal, Urandangi, Dajarra and Wunara. Mt Isa is the regional commerce centre and sits just outside of the Georgina Basin proper, to its east in Queensland's North West Highlands. Mt Isa is a mining town with a population of 20,570 [23] including an Indigenous population of 3070 which represents 14.9% of the total population. Outside of Mt Isa, the population is sparse across the UGRB, and includes the residents of pastoral stations and small towns, including Dajarra with a population of 191, the majority of whom (60.3%) are Indigenous [24].

The study region lies in the arid climate zone of Australia and is broadly defined by a hot wet season (November to February) with extremely high temperatures during the months of December and January, contrasting with a winter or 'dry' season (April to September) when temperatures are cooler and less rain falls. Between these seasons, the days can be extremely hot, and overall, the variation in climate from year-to-year, including rainfall is considerable. Records from the 20th century show an increase in average temperatures which has been

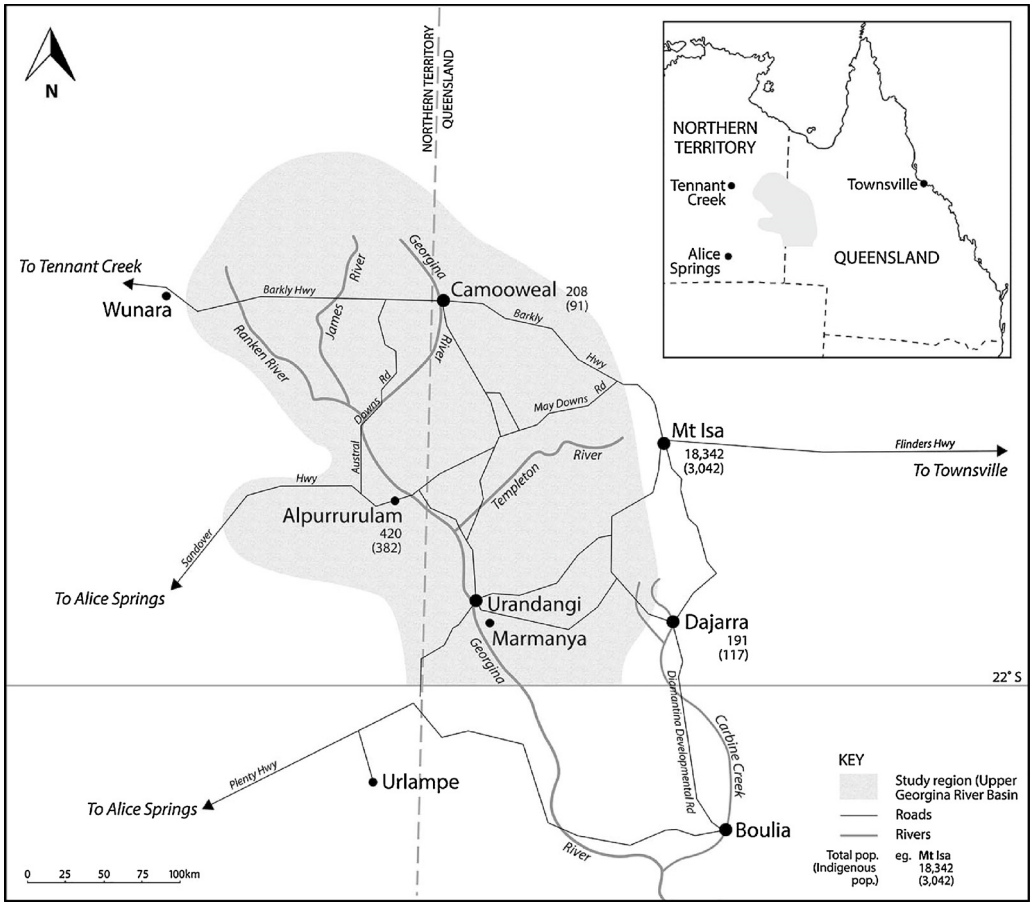

Fig. 1. The study region showing the main rivers, roads and population centres.
Source: ABS 2016 Census and AERC Archives [82].

predicted to continue rising through the 21st century [25]. Current projections made for the wider study show that average temperatures will rise by between 1.5 °C–5 °C towards the end of the 21st century with slight variations on a seasonal basis—with long dry winters to remain long but become drier with possibly more flooding events, and bush fire frequency to increase in late spring and early summer, but dust storm frequency uncertain ([17]: 55).

All anticipated environmental transformations will clearly have important ramifications for the people in the UGRB region that are not only ecological or demographic but also cultural, as for other regions of the world. More specifically, it is not known to which extent climate change will influence the carrying capacity of human life in the local environment, how much it will affect the relative size of the local population and the extent to which they will be forced to move. The UGRB has specific geographical, ecological and demographic characteristics, but attention to these alone does not tell the full story. In a study of mobility in the region, Memmott et al. ([26]: 3) found that mobility patterns were diverse and complex, with “an inner region of common movement” intersecting with the “movement patterns of individual communities” that varied depending upon “their unique history of past migration and particular cultural and socio-economic linkages”.

High circular mobility and wide social networks amongst the Aboriginal settlement populations within the region have meant that an individual grows up enculturated into a cultural landscape with life experiences of the spectrum of diverse environmental place types. Mt Isa and Dajarra are on the edge of the rugged highlands renowned for rugged scenery, minerals, rock pools, as well as rock art and stone tool manufacture from classical Aboriginal times. Camooweal and Dajarra are in the black-cracking clayey soils of the Barkly Tableland, characterised by the vast grasslands and cattle stations cross-cut by the Georgina River and its tributaries with coolibah-lined perennial waterholes, supporting fish and birdlife. Alpurrurulam and Wunara on the west, are at the edge of the red-sand deserts that stretch to Central Australia and covered with spinifex hummock grasslands receiving only low rainfall. At times, all of these places are subject to drought, bushfire, dust storms and floods. In 2011 during a period of an extreme weather (related to Cyclone Yasi), many residents evacuated their community to link up with family in less affected places, confident in their local knowledge across considerable distances and a range of environments.

Prior to settlement of the region in late 1800s, Aboriginal groups were the resident hunter-gatherer landholders (see Fig. 2) and many Georgina River people today can trace their ancestry to these and other groups. Although Aboriginal knowledge and practices have been disrupted over the course of European settlement, important links to the past have endured this turbulent history, such as the Aboriginal institution of rain-making. Our investigations revealed that some Georgina people’s views of weather and climate change were influenced by beliefs associated with such practices. Georgina River people’s culture and social relations have survived, and adapted in response to the transformations in the regional political economy and social geography. Aboriginal people have always been in the ‘script’ of social change and environmental care in the region, though not always in a position of autonomy and power.

3. Crossing disciplinary borders

We often rely upon scientific discourses to understand ‘climate’ as a complex biophysical system spanning the globe, and to apprehend the social, economic and biological transformations that are likely to occur

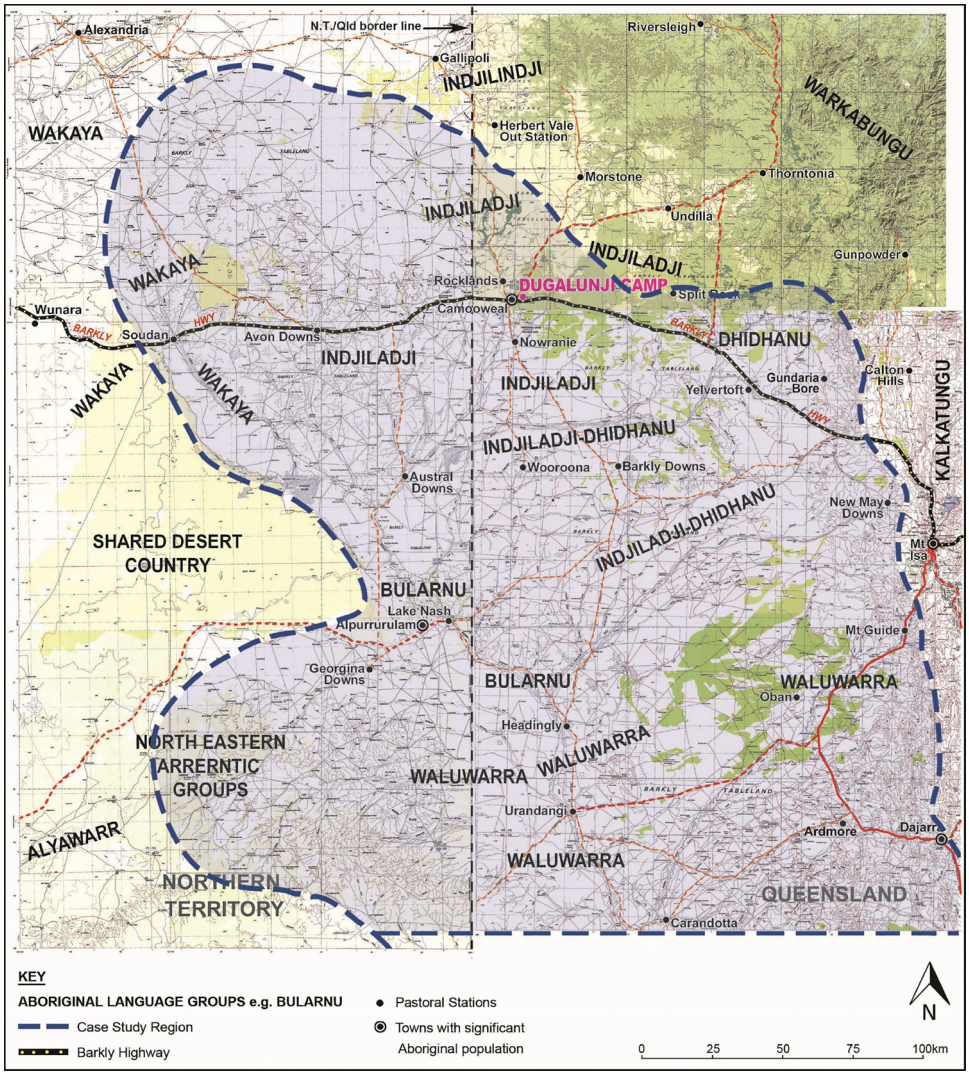

Fig. 2. Aboriginal language groups, pastoral stations and towns in the Upper Georgina River Basin.
Source: AERC Archives.

in the context of a changing climate. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (2014) painted a stark picture of the ways that anthropogenic climate change would impact societies all over the world. In the context of the impacts from rising sea levels, warming oceans and changes to weather patterns and systems, climate change can be understood "simultaneously as physical transformation and a cultural object, as a mutating hybrid entity in which the strained lines between the natural and the cultural are dissolving" ([27]: 5). The recognition of the 'embeddedness' of climate in cultural systems, and vice versa, has led to questions about the extent to which the natural sciences can comprehensively deal with issues of politics, culture and social change that arise in the context of climate change [28].

The epistemological boundaries that historically separated climate science and the humanities and social sciences are not so much being eroded, but are rather becoming new sites of interdisciplinary engagement and collaboration (e.g., [19,29–33]). Indeed, it is widely agreed that despite the fact that Indigenous peoples are the least responsible for generating the emissions that drive anthropogenic climate change, they also stand to suffer the greatest degree of social and cultural displacement [19,34]. Anthropological enquiries into the impacts of climate change on indigenous peoples have been fruitful, as they give priority to questions of culture and cultural change (e.g., [35–38]).

Previously, climate change research has been largely dominated by the natural and physical sciences, which, while important, tend to be disposed towards "the prediction of effects and seeking technological and infrastructural solutions" ([13]: 681; see also [39]: 102). Furthermore, climate change adaptation has been thought about almost exclusively as the domain of formal institutions of public policy and governance, which in turn privilege scientific accounts of climate change risk, and economistic conceptions of the costs and benefits of adaptation. As noted above, the privileging of particular understandings of climate change effects, without engaging with other knowledge systems, is fraught with problems. Minimally, "limiting research to one 'correct' view of the world may constrain the understanding of complex environmental phenomena as global change" ([40]: 319). Riedlinger and Berkes ([40]: 321) also suggest that a "primary difference between western science and traditional knowledge is … traditional knowledge holders are the resource users themselves, and their knowledge is grounded in the observation of environment and resources over an extended period of time" (see also [36]). Indigenous peoples offer unique perspectives, capacities and methods for observing

change, because of the nature and practice of knowledge production [41].

4. Mixed methods

Our research team was multidisciplinary, with expertise in the social sciences and natural sciences, including social anthropology, architecture, social and environmental psychology, political science and environmental and climate science, as well as in cross-cultural research. Several whole team (and sub-group) meetings in the planning, development and analysis stages were important for resolving differences about the best approach to methods and interpretation of concepts. The common research interest and experience of working with First Nations peoples particularly Indigenous Australians facilitated an integrated interdisciplinary approach. For this project however, the principal methodological challenge was the joining of quantitative and more psychological and psychometric methods, with a qualitative and cross-cultural approach in order to make meaningful comparisons with the national surveys.

In order to address the epistemological tasks outlined above, the team chose a mixed methods approach to data collection [42,43]. The two main techniques were a research survey administered in the field and in a face-to-face interview context and adapted for use with this participant group, followed by two Focus Group workshops. As the primary investigative tool, the specially designed survey embedded quantitative and qualitative methods to document and measure Aboriginal perceptions and knowledge of climate and climate change in the UGRB. While the survey methodology used selected rating items from the national survey and composite psychometric measures, these were interspersed with more qualitative open-ended questions and responses which emerged in the context of a more conversational format. Following the administration of individual surveys, the study explored adaptation strategies and the capacity of the UGRB communities through the community workshops held in the region.

4.1. Designing and delivering the survey

The combined objective of the project, to document then compare the quantitative data from the survey with relevant national survey data, required some modification of the design. Certain dilemmas arose as each question of the national survey was examined for possible inclusion or change, and some additional questions were formulated (illustrated in following paragraph). The main criteria for changes were to promote understanding of the questions and to increase the capacity of the survey to collect data that might be specific to the local region and to Aboriginal people. At the same time, it was important to keep in mind that any unnecessary changes might compromise the validity of a comparison between the two sets of results.

The modification of the survey's section on 'Climate and Weather' (see [17]: 218–221) illustrates how some questions were tailored to the respondent group. After close consultation between the anthropologists and Georgina Basin (GB) representatives, the construct of 'weather changes' was introduced, being a common subject of discussion in the community compared to 'climate change'. Whereas in the national survey, a tranche of questions towards the beginning of the survey asked about causes, effects and ways of reducing climate change, the GB survey focused on changing weather patterns and opinions about climate change. Once again, unlike the national survey, the GB survey included qualitative questions for the respondents to expand on their views about whether and how the climate and weather had changed over the last few decades and the reasons for the changes. In this way, the survey elicited data that helped to explain Aboriginal people's perceptions of the level of risk posed by climate change, and in many cases, their understandings had local cultural components. As long-term residents of small remote communities, their considerable knowledge of, and close connection to, their natural environment was evident.

The survey interviews were conducted in Alpurrurulam, Camooweal, Dajarra and Urandangi during May, August and September 2012. Of the total 72 respondents, 69 were Aboriginal (40 males and 29 females). All persons aged 18 and over were welcome to participate and each respondent received $AUD30.00 cash payment on completion of the survey. The respondents were not a formal representative sample of the local Aboriginal population. Our survey recruited more male respondents than females and most respondents were middle-aged and over. However, with a broad age-range (17–81) and a total 72 respondents, the sample was arguably a robust one given the relatively small population of the UGRB region (see Section 2) and the distinctive cultural and life circumstances, including remoteness, that the Georgina Indigenous communities share.

'Key informant' and 'snowballing' methods were used effectively by the team and frequently relied on the team's established contacts through previous work in the region. Following accepted cross-cultural research protocols, the interview team included a male and a female interviewer working closely with the Aboriginal team member. People's willingness to participate was most likely due to the kinship and social networks of the Aboriginal team member who accompanied the field interviewers throughout the investigations. On the other hand, his role may have introduced some bias by slightly inflating the numbers of middle-aged respondents. It is important to point out that the Georgina Indigenous community included a range of subjectivities in which differences of age, gender, life experiences and other socio-demographic factors influenced knowledge and perceptions of climate change and these were reflected in the survey responses.

The interviews consisted of 52 questions that required the respondent to choose from set responses, including 'Yes' or 'No' (e.g. Q13. Have you seen changes to these weather patterns over the past ten years or so compared to earlier years?) and for other questions, responses based on variants of a Likert-type scale (e.g., strongly agree, agree, disagree, strongly disagree, don't know), as well as sets of open-ended questions which were interspersed throughout the survey. The known cultural preference for avoiding strong open disagreement (e.g. see [44]) was arguably addressed by the choice of relative disagreement and agreement as a response. Moreover, the presence and effects of climate change are indeed real for Indigenous Australians as this and other studies have shown.

On average, the survey took one hour to complete and was conducted face-to-face and mostly in people's homes, with the total number of interviews being completed over a few days. Interviews were conducted in English with Aboriginal English paraphrasing by the interviewer as required. The national survey used two sequenced (2010 and 2011) online Panel Surveys administered by a wel L-R espected research survey service (Qualtrics). In a similar way to Georgina surveys, respondents were presented with the selected survey items in a visual form with a visual format for the rating scales. Both survey modes allowed for some qualitative, open-ended responses to particularly important questions relating risk perceptions and understandings of climate change relating to risk. It is important to point out that both the national surveys and the Georgina survey used standardised items, either identical to or very similar to developed items in North America and Europe as well as Australia, reflecting the multicultural backgrounds of the national samples. In the Georgina survey more conversational language was used for some questions and also in the survey administration some situational explanation assisted understanding with some more traditionally oriented respondents. The advantages and at times necessity of such situational explanation and expansion in the case of particular survey questions strongly outweigh and indeed counter any 'comparison' disadvantages.

4.2. The workshops

Two regional Focus Group workshops took place near Camooweal at the training facility of the Dugalunji Aboriginal Corporation, bringing

together Aboriginal community representatives from the field locations and other local and regional stakeholder groups in an Aboriginal-developed facility. The workshops (held in August and November 2012) selectively focused on four research themes that were explored in parts of the survey: preparedness, land and riverine management, housing and infrastructure and enterprise development. Although participants talked of their experiences, the workshop discussions directed attention to adaptation responses, with less emphasis on risk perceptions, understandings and responses to the phenomenon and threats of climate change. Nevertheless the notion of risk in relation to the environment is highly salient for the Georgina communities to the extent that their worldviews include the attribution of environmental conditions and changes to human causality, responsibility and accountability. It is arguable that the anthropocentric character of climate change is both a naturally assumed and unquestionable feature of climate change for most traditionally-oriented Indigenous Australians.

Inclusion of the workshops and focus group process was based on the premise that local collective action can be a most effective way to prepare for adapting to climate change in the future. In common with other Participatory Action Research (PAR), including on climate change [45], the workshop and focus groups aimed to facilitate change in local practice that is rational, sustainable and based on principles of justice and equality. The workshops provided opportunities for Georgina people to share their views about local ecological and climatic phenomena, including extreme weather events which they had experienced. The group explored their concerns with regional stakeholders about resources and services that were currently available for emergency support, but also for strategic planning for adaptation to climate change. A digital video-recording of the workshop proceedings documented an important stage in the potential development of local adaptation strategies.

Aspects of rapid ethnographic data collection [46] and Participatory Action Research [47] influenced the data collection and analysis throughout the project, particularly in the workshops. Most significantly, Indigenous community involvement was integral from the planning stages through to the data collection, analysis and dissemination of results, particularly through engagement with the local Indigenous team member.

It is important to point out that we acknowledge the contested nature of 'community' in the context of Indigenous Australians, and the potential issues around defining people by the term (e.g., see [48]), including in the context of 'community' surveys. For this study, the Indigenous community was a diverse residential group, and a de facto and recognised community residing in this remote catchment area of the Georgina River. We sampled a reasonably representative group of individuals from that population reflecting the demographic characteristics, including differing age cohorts, residence locations, individual residential mobility, formal education and general experience backgrounds and English language fluency. Any such survey findings relating to survey item responses are reported through an initial analysis and description of descriptive statistics relating to sampled *group level* frequencies, means, ranges, correlations, etc. The size and nature of our *community sample* did not really allow for more sophisticated multivariate statistical analyses but did allow for a direct comparison of these descriptive statistics with our robust *national population sample* descriptive statistical findings. Our sample also provided an initial database in the context of future monitoring of views and key parameters relating to the psychological and social impacts and adaptation responses and possibilities relating to the ongoing threat and unfolding physical environmental impacts of climate change. The research was qualitative as well as quantitative, and salient individual risk perceptions, causal attributions, views, and personal experiences and impacts were recorded and reported from the open-ended survey responses and the workshop discussions. We suitably qualified our findings with respect to any generalisations to the much wider distribution and circumstances of remote indigenous communities across Northern Australia. We have not conflated our group and individual levels of analysis, and we have referred to community views and findings in a very informed, reflective, and conventional social science reporting manner.

5. Discussion of findings and methods

5.1. Comparisons between national surveys and UGRB survey

In keeping with the aims of the project, the UGRB survey findings were compared with the findings of the national Australian survey [49,50]. The surveys contrasted greatly in scale (UGRB n = 72; national surveys 2010, n = 3096 and 2011, n = 4347), but also in the social and cultural contexts of the population centres, that dictated some changes to the national survey format. As a result, the Georgina survey included fewer questions but also considered the backgrounds of the individuals who had been living in small, remote population centres in comparison to the backgrounds of members of the broader Australian community. Many survey respondents from the Georgina River community were relatively unfamiliar with surveys, and particularly a more structured and standardised national survey, and the language used regarding climate change concepts. Hence the modified survey items and the less formal but standardised face-to-face presentation, and explanation where necessary, reflected this reality, and the objective of obtaining genuine thoughts, feelings, and understandings of 'climate change' and changing local, known, environments as well as the global environment. Individual thoughts and feelings expressed, particularly in the open-ended responses were noted, recorded, and considered in our comprehensive research monograph (viz. [17]). The success of the modified situational and culture-sensitive administration of the survey ensured that quite valid and meaningful comparisons could be made with respective national findings.

There were a number of issues in our study in that there were real differences in survey administration (e.g., online administration of national survey, differing presentation and ordering of selected survey items used from the national survey, proxy rating of scaled items for some respondents, the possibly different understanding of the wording and framing of the questions asked, etc.). However, many of these differences are an inherent aspect and challenge in cross-cultural research generally (e.g., [51,52]) and in cross-cultural research utilising survey research methods, and we addressed these in an informed and reasonable way given the challenges involved in our research study. The research team had considerable cross-cultural research experience and included local indigenous research advisors and assistants. In addition many if not most of our Georgina area respondents are multicultural Indigenous Australians, who, despite their remote location, are regularly exposed to the domestic and international 'information environment'. 'Climate change' was not a new or unfamiliar topic and in many ways is a quintessentially Indigenous Australian issue and consideration. This is not to say that a remote community indigenous perspective is not different in many important respects, and indeed addressing, documenting, and characterising such likely differences was a core focus of our research.

So while acknowledging the elements of dissimilarity between the national and Georgina survey content and administration, the project findings suggested that valid comparisons could be made. Some of the more striking comparisons are provided in the Table 1 below.

Acceptance of the reality of climate change by respondents of both the UGRB survey and the national surveys was almost identical (c.75%), however self-reported i.e. subjective knowledge, that might inform this view was markedly different with UGRB respondents feeling less confident about specific aspects of climate change as used by researchers. Furthermore 44% of Georgina Basin respondents thought that the effects of changes would be felt far away from them whereas only 8% of the national survey respondents thought that way. Significantly, 54% of Georgina Basin people reported personal

Table 1
Selected comparisons from Australian National Surveys and the UGRB Survey.

Survey constructs	UGRB survey % of respondents	National survey (2010 & 2011) % of respondents
Acceptance of climate change	75% (#16 A)[a]	74% (2011)
Self-reported knowledge of climate change	65% reported little knowledge (#22)	72% reported substantial knowledge
Effects of climate change will be mostly be far away	44% *(#23)*	8%
Reported personal experience of environmental change associated with climate change	42% (#24)	45%
'Worried'/concerned about climate change	60% (#36)	64%

[a] Item number in UGRB survey (see Appendix 1 in Memmott et al. [17]).

experience with natural disaster compared to only 37% of national survey respondents in 2010, and 60% of Georgina Basin respondents reported being worried about the specific aspects of climate change compared to 64% of national survey respondents in 2011 who reported being 'very' or 'fairly' concerned (see [17]: 77–86; 92–106; 116–123; 144–147; 159).

Such comparisons of emotional response or psychological impact cannot be fully understood from our survey findings, given some cultural and local language differences in emotion-related wording of several survey items. However, the findings suggest that indigenous worldviews were influencing the respondents' attitudes and knowledge of environmental changes, including identifying these changes as a cause for 'worry' (the term substituted for 'concern' used in national surveys). While the majority of the GB respondents reported 'little knowledge' of climate change, other responses demonstrated their considerable knowledge of local climatic features and dynamics in the environment.

Although significant for Georgina people, the perception of risks associated with climate change appears to be in the background compared to more general, immediate and familiar weather and climate impacts. Consequently, specific concerns about climate change appear to be less relevant in the lives of Georgina people compared to the broader Australian community. At the same time however the UGRB respondents do recognise and are responding to changes, as they are understood by climate scientists, and the research pursued the potential for appropriate adaptive responses.

The inclusion of open-ended questions in the Georgina survey was significant as the responses provided useful clarification about the extent of people's knowledge and opinions. While this kind of 'rapid ethnography' is accepted practice in the social sciences as a way of collecting data to inform a multi-layered, textured analysis of aspects of social and cultural life in a relatively short time frame [53,54], the project also relied on the prior knowledge of the researchers. Non-Indigenous members of the field research team had worked across the region in different roles relating to academic and community research, architecture and school education, and had established relationships with Indigenous family groups at different times over many years. As returning visitors and 'trusted outsiders' [55] to the Aboriginal communities involved in the study, the researchers were aware of potential colonising impacts of the research process and were committed to respectful engagement with community members. To this end, the local Indigenous team member assumed a key role in communicating with the community and engaging with interested participants. Open clear communication with local leaders was a priority as was providing a local Indigenous enterprise with the opportunity to partner with the project during the 'on country' workshops (see Section 5.2). The relatively large number of willing participants evidenced the significant degree of interest and acceptance afforded to the researchers and the topic under study. In this framework the participants were comfortable to share with the project team their on-going understandings and interpretation of complex cultural issues within the Georgina River region, including knowledge of individual people, language and protocols in the field locations.

5.2. Focus Group workshops and other ways of knowing

It was a feature of the workshops that the Aboriginal representatives were dealing with different knowledge traditions that would have relevance to adaptation strategies in their own communities. A key component of the workshop methodology was the opportunity to synthesise different bodies of knowledge, as is the standard approach of trans-disciplinary research [56]. Through different methods, efforts were made to move beyond the scientific facts as the *only* representations of the biophysical world and as explanations of climate change, and find out about the ways in which people respond to the environment and how they make decisions on how to behave and respond to it.

Georgina Basin people contributed to the project knowledge in conventional ways, including surveys and workshop protocols, however they also contributed other ways of knowing [57] within the research framework. In the first workshop participants readily shared their weather stories and experiences—each person's story spurring on another, in yarning narrative style [58].

Workshop discussion featured a litany of physical manifestations attributed to changing weather patterns as the Aboriginal participants demonstrated their knowledge and experience of change across a wide range of phenomena.

> *When I was a kid, I remember fishes fell out of the sky in Dajarra. And in Boulia I saw crabs fall out of the sky* (Waluwarra woman).
> *Raining fish was common when I was a kid. We used to dam the gutters in Camooweal and collect the perch and put them back in the river* (Alyawarr woman).
> *Dust storms used to be so bad you couldn't see the Georgina. It was a black cloud like rain* (Waluwarra man).
> *We had a hail storm last year at Alpurrurulam. It's the first time we've ever seen hail at Alpurrurulam. Weather pattern now is changing all the time. It's always cold/hot/cold/hot 'snaps'. It's not predictable* (Alyawarr man).

The Georgina Basin people recalled how they have adapted in the face of this unpredictability and they communicated a sense of agency if not complete control over their environment and their life circumstances.

We still go to the bush. There used to be bush fruits flowering everywhere but they are not in abundance anymore (Waluwarra woman).

Alpurrurulam hunters must go half way to Isa to get kangaroo. Ampelatwatje hunters have to come to Alpurrurulam for kangaroo. Bush turkey and kangaroo have all come this way, to the north (Male traditional owner group).

All that river has been alive – you could see the fish. We use to get mussels and cook them on the fire. Now the water is muddy. Is it climate change? Or is it the way government has taken country? Or is it us forgetting our old ways? We don't sit down in the bush enough (Indjalandji-Dhidanu man).

The Georgina River belongs to everyone. Dreamings [tracks of the ancestral beings that created the land] come from all sides East, West, South, North. They join and link everyone together. And don't forget we built the cattle stations of the Barkly, not that we resent that [because stations are owned by non-Indigenous], but our grandfathers and grandmothers built the stations (Alyawarr woman).

These remarkable recollections of raining fish, big winds, dark dust storms and redistribution of resources centred on the theme of change. Stories were a way of building shared understanding about broad ranging concerns around the seasonal pulses and transforming weather patterns experienced in their lifetimes. The yarning denoted a resilient attitude against the grain of victimhood that is prevalent around Indigenous peoples and climate change [59]. Despite living with structural impediments from the ongoing effects of colonisation, including high levels of socio-economic disadvantage, many Indigenous groups continue to survive using resources from their land, although often experiencing vulnerabilities due to the effects of climate change. It is important to not view them simply as victims but to understand their resilience as part their potential and developing adaptive capacity [83,16]

We recognise that individuals in the Georgina region had diverse knowledge and experience of climate change for understanding climate change and related phenomena. Nevertheless some participants had experienced extreme weather events and had connected this to global events as well as the experiences of other groups in ways that were transformative: *Cylcone Yasi ripped the leaves off trees … now if you get a cyclone that far inland, surely it's to do with climate change. We're the same as the Inuit!* (Waluwarra woman, Mt Isa). The contribution of stories as data, inquiry and process [60] was complementary to the quantitative approach and provided a more nuanced account of Aboriginal lives and worldviews in the study region.

As knowledge is shaped by experience and located within stories [61], it can be represented and explored in other texts, including visual media.

The Georgina team member, Keith Marshall, photographed the local landscape and settlements, presenting another kind of commentary on the changing Georgina region and the effects of changing weather and climate patterns. This archive of 400 images (selection in Fig. 3) then became an effective integrating resource for the project providing a local Indigenous perspective via a visual medium. The images informed the workshop discussions, and were used by the researchers as part of the dissemination of preliminary findings at a national climate change conference and also in the final report of the project. The process of image-making and presentation of the images demonstrated salient aspects of local Aboriginal worldviews about people's relationship to the country. By speaking to the images and through the reception of the images by others in the workshop, the process emphasised the extensive knowledge about places, plants, animals and ecological processes including climate/weather in ways that a list of species or physical description could not achieve.

Like the images, other art forms demonstrated ways of knowing. A senior Traditional Owner, Shirley MacNamara, showcased her spinifex fibre art to the workshop group. As a highly acclaimed mixed-media artist [62], Shirley's knowledge and use of local resources in the art was dramatically highlighted, adding another dimension to knowing about the natural world and people's place within it. Implicit in her knowledge are the political and personal ideas associated with the motivation of Aboriginal people to continue to live and work on their country, knowing and caring for it. Furthermore, there are many ways of expressing strong connections to the land including new art forms such as her spinifex sculptures (see Fig. 4). This knowledge suggests a resilience that is linked to the desire of Georgina people to stay living in their communities regardless of perceived threats from changing climate.

Opportunities to express other ways of knowing in qualitative

Fig. 3. Scenes from the Upper Georgina River Basin: L-R (top) Wunara outstation in the Wakaya Desert; Wild orange 'atwakey' (*Capparis mitchelli*); (bottom) Gidgee (*Acacia cambagei*) with edible gum; Georgina River at Camooweal. Photos by Waluwarra man, Keith Marshall.
Image source: AERC Archives.

Fig. 4. Artwork by Indjalandji-Dhidhanu/Alyawarr woman Shirley MacNamara [woven spinifex (*Triodia pungens*), emu feathers and ochre]. Project workshop, Dugalundji Aboriginal Corporation, Camooweal, August 2012.
Image source: AERC Archives.

research can create a platform for Indigenous voices to be heard. Instead of merely corroborating scientific knowledge (e.g. of plant and animal species and of ecological changes) visual forms created by Aboriginal people can communicate ideas and values from a non-scientific perspective. The methodology described herein does not constitute an Indigenous research framework [63], in which Indigenous people not only collaborate but also lead research, and arguably our approach was limited in this way. Nevertheless the data can be useful when viewed in conjunction with other qualitative responses for building a more complete picture of people's placed-based perceptions and knowledge and its relevance to adaptive capacity.

6. Assessing the approach

How well did the approach and methods serve the aims of the project? Our dual focus on psychological aspects of responses to climate change and practical adaptation strategies influenced the methods for our investigations, and with the survey accessed cognitive and affective environmental perception responses, and elicited both individual and culturally based shared understandings. The survey administration allowed people to talk about their personal experiences and these findings then grounded discussions in the workshops on potential adaptive responses. The distinctive value of our study methods is linked to this approach.

6.1. Quantitative and qualitative methods in survey

The modified survey for the Georgina Basin respondents took into account the differences across the cultural and life differences between the Georgina Basin and the national survey groups. Having a similar format, the quantitative questions in the modified survey were coded and statistically described following the national survey while the qualitative responses were reviewed and analysed using a developed coding scheme and two postgraduate research student assistants with cross-cultural and the national survey experience and expertise. In addition, the researchers responsible for each research stream identified key responses and dominant themes in order to identify elements of a local cultural framework for understandings and knowledge of climate change. To address possible bias, these findings were reviewed and discussed by others on the research team throughout the findings process. The integration of qualitative and quantitative data that were considered concurrently, contributed to the richness of the findings.

The methods adapted for the UGRB study may be applicable to Aboriginal communities in other regions although more work is needed to understand the nature and extent of potential similarities and differences. These include matters such as objective and subjective knowledge of climate change as a phenomenon and environmental risk domain (with respect to lay understandings and use of 'climate change' among Aboriginal Australians living in remote areas such as the Georgina River catchment), as well as the underlying causes of climate change itself, and to observed and noteworthy local environment changes and conditions. The significance of different, local cultural factors in the description and analysis of issues relating to Aboriginal people has been highlighted in a wide range of research topics including climate change (e.g., [13]). It is understood that traditional cultural values, beliefs and practices continue to be highly important considerations in remote and regional Aboriginal communities. It is also appreciated that each Aboriginal group interprets their culture in ways that are specific to their environment and that methods for investigating what people know and how they think about and use the environment can benefit from a locally developed approach, e.g., kaparti methodology [64] and caring for Bawaka Country [65].

Aspects of validity and reliability of findings were considered for our project while at the same time recognising that such 'tests' are not necessarily applicable to qualitative investigations [47]. The study region may indeed share some cultural and environmental similarities with other rangeland Aboriginal groups. More significantly, the findings from previous research work carried out in the region, including studies on settlements [66]; regional mobility [26] and water resources [67] offered opportunities for triangulation, a common process of qualitative research [47]. The findings from these and other studies demonstrate consistency over the last decade with regard to particular adaptive dilemmas and strategies. Our integrated qualitative and quantitative research methods and resulting findings in their own way supported an advocacy role of the project, providing a very credible and distinctive indigenous voice and perspective from the UGRB community with respect to fostering further resilience and adaptation capacity.

6.2. Reflecting on workshop approach

Following the logic of our methodology, the study used the survey findings to develop the workshop investigations on strategies for adaptation that might be employed by Aboriginal people in the region. These investigations were largely based upon conversations with local stakeholders, the majority of whom were Aboriginal residents of the UGRB. Discussions revolved around the four themes that are central to climate change adaptation (see Section 4.2). Given the complex and multidimensional nature of regional risks and vulnerability to climate change, and the varying perceptions of climate change within the region, it was inevitable that discussion included both the barriers to and opportunities for successful and sustainable climate change adaptation in the region. A broader range of stakeholders participated in the workshops, with representatives from government agencies and non-governmental organisations also in attendance. (The reader is referred to Memmott et al. [17]: Part B, for discussion on the many proposals that were formulated under the focus groups which are too lengthy to report on in detail herein.)

The workshop discussions established the importance of place connections in potential adaptation strategies. Given the opportunity to speak about adaptation and the possible effects of climate change on their community, people demonstrated a very strong place-attachment that linked them by inherited responsibilities to kin and land, with this reflected in their equally strong desire and intention to remain in the region. Although connection to place can be a barrier to adaptation (e.g., [68]), Georgina people are known to be mobile both within the region and beyond, particularly to adjacent regions in the NT and Queensland [26]. Their visits to kin, often reciprocal, may extend over days, weeks or months—a practice which is supportive of family network connections. This practice also confers social and psychological resilience providing potential adaptive advantages if people need to change their place of residence.

6.3. Knowledge and perceptions—integrated approach needed

While important topics were identified through the project, the investigation of Aboriginal place-based knowledge and understandings is preliminary but also a primary focus. Throughout the survey interviews and workshop components of the research, the respondents conveyed their concern for the lack of resource management, e.g., raising issues about the deterioration of water sources from invasive and exotic species, and impacts on resources. The workshops provided a forum for discussion and potentially a step towards better coordination between Aboriginal people and environmental management authorities. With this focus, Traditional owners have begun to document their local environmental knowledge in relation to natural resource management [69,70].

Records of ecological research in the study region informed the project however much more local knowledge came to light during our investigations. Questioning about resource use resulted in the compilation of a seasonal calendar that set down baseline information about the local patterns in the seasonal cycle as understood by local Aboriginal people (see [17]: 125–128). While our methods arguably relied on scientific categories relating to life cycles and patterns of ecological dynamics, the investigations were productive in recording local understandings. As an example, the research produced a tabulated list of indicator species and associated phenomena, including the cry of the cuckoo as a sign of rain, and goannas coming out from hibernation, following the time when you see the cracks in the ground from the bush potato. It should be noted however that this kind of record can only be a partial representation of what people know, and particularly in relation to environmental changes. Although TEK and local environmental knowledge are relevant to the effects of climate change, it is important to recognise that such knowledges do not exist as static, disembodied and objective entities. Aspects of place, such as landforms, plant and animal species and other natural phenomena are central to values and worldviews culturally reproduced on a day-to-day basis. Our preliminary research in this area adds to current understandings of the human-place relationships that are under-explored at this scale for the Georgina River region.

From an anthropological perspective, Aboriginal people hold a relational approach to the environment, shaped by their objective knowledge of the world and how it works but based on notions of reciprocity and ancestral and spiritual responsibilities with cultural connections that ground their relationships in kin and place [71]. The notion of relational ontology or worldview emphasises the interdependence of human and non-human parts of the natural world in contrast to perceived western views characterised by the nature-culture divide. In this study, a relational approach is referenced in the following survey responses:

> *The kangaroos are fat, yellow bellies biting. We might live in the city but traditional country still has to sustain us.* (Waluwarra woman, Mt Isa*) Growing up with my people they were the weather people.They could change the weather. I've seen it myself. You may not believe me but they've all gone and they didn't pass it on to us. They had songs for cyclone, wind, you could ask them for help. Good for hunting. The old people could control the seasons.* (Wambaya man, Camooweal)

This interdependent relationship is integral to the Aboriginal people's concept of 'person' and includes a significant emotional dimension within their cognitive framework [72]. One of the likely effects of climate change is that it will transform these place-based understandings (e.g., [19]). It is reasonable therefore that from a psychological perspective, emotional and conceptual responses (risk-as-feelings and risk-as-analysis) may be far more fundamental than objective knowledge in determining individual-level risk appraisals and responses.

Herein lies the significance of our methodological approach for finding out about people's perceptions, and further work needs to be done. Attention to local stories and individual worldviews can provide an insight into motivations and actions, e.g., a culturally-based Indigenous approach is fundamental to the work done in Bawaka Country that acknowledges the agency of country and the role of the people who are responsible for it [65]. Our approach follows that of others in recognising the role of both scientific inquiry and Indigenous stewardship protocols [73] for promoting sustainability. Unfortunately, policy makers and planners in Australia have not adopted culturally-based adaptive solutions to environmental management nationally, thereby foregoing opportunities to engage most effectively with local communities who know and care most about their environment but who require substantial support to undertake the work. Instead Australian governments at all levels and of different persuasions have failed to deliver adequate support to Indigenous communities, particularly for resource management in remote Australia. The Caring for Country program which operates in selected locations, is an exception but despite its positive contributions, the socio-economic indicators have demonstrated that marginalisation and disadvantage persist for Indigenous people in those and other communities across the country [74].

7. Discussion

Notwithstanding an encompassing literature on culture and risk perception (e.g. [75,76]) there has been little focus to date on climate change risk perception per se (e.g., [77]). Yet there are compelling reasons for thinking that more traditional indigenous environmental risk perception assumptions and understandings are particularly salient and consequential. In the context of more traditional Indigenous Australian worldviews, extreme weather events and noteworthy environmental changes and disruptions are typically perceived and understood as being human-caused, and are routinely attributed to malicious acts of individuals from other clans and regions, or the instrumentality of a pantheon of creation beings. A revealing and well-documented example is that of indigenous perceptions and understandings of the cause and devastation of Cyclone Tracy in Darwin across traditional communities in Northern Australia, with this event being seen as a dire warning by the Rainbow Serpent with respect to keeping culture strong (e.g., [78]). The Aboriginal people from the Georgina River region also acknowledged human influence over rain-making (see Section 2) and other aspects of weather (see Section 6.3) albeit suggesting a more benign intent. Yet, this traditional culture take on human instrumentality in noteworthy environmental events and changes can still elicit considerable risk and dread. This 'worry' reflects a synthesis of indigenous and contemporary worldviews in today's remote Aboriginal communities, encompassing convergent concerns with what seems to be a potentially existential global threat to ecosystems and biodiversity in contemporary media coverage of global climate change. Such causal attribution and sense-making may also, and somewhat paradoxically, enhance collective efficacy in the context of climate change adaptation, while reflecting a far more integral cultural connection with the natural world (e.g., [79,80,84].

We have emphasised that Indigenous Australians living in remote communities have either intermittent or regular access and exposure to, global media coverage of climate change, and represent quite varied individual formal education backgrounds. In addition, language and communication challenges, while often real, are typically overcome through researcher familiarity with local languages and culture and the assistance of community members. As well, the subject matter of salient changes to local environments and ecosystems, and possible explanations for such changes, is of particular interest to and an ongoing conversation and discussion in these communities. We have also underscored the fact that cross-cultural consideration of the environmental risk domain of global climate change becomes particularly interesting and challenging when conventional distinctions between natural and human-influenced or technological do not necessarily apply, and in a cultural context and underlying cosmology in which all

significant environmental events and changes are human-influenced or directly human caused. Despite such challenges, what is particularly interesting and noteworthy is that our research clearly suggests that remote community Indigenous Australian risk perceptions, understandings, and responses to global climate change are both 'same and different' to those of their fellow Australians, and that appreciation of these cultural and environmental experience-based similarities and differences is clearly important in informing collaborative climate change adaptation initiatives and policies.

A standout and often-mentioned cultural and regional difference is that these communities' connection to their traditional 'country' will make any recommended relocations in the face of climate change impacts extremely difficult. A further prominent finding is that a number of important aspects of indigenous and mainstream Australian climate change risk perceptions, experiences, and responses are strikingly similar, with reported personal encounters with environmental changes, conditions, and events deemed to be manifestations of climate change almost identical, 45% vs 43%, as are prevailing high levels of preoccupation and concern. It would also appear that deep connection to and identification with the 'natural' environment understandably increases not only concern and distress with respect to impending and dramatic climate change, but also collective self-efficacy and resolve.

8. Conclusion

A multidisciplinary mixed-methods approach that combined a modified survey with community workshops brought a distinctive geographic and local Indigenous focus to the study on Aboriginal people's perceptions of climate change. The research reveals a different story about the ways that geographical scale intersects with the perceptions and experiences of the Aboriginal people of the UGRB. The research team has produced new data that allows for the co-production of 'bottom up' knowledge that is both situated and contextual, while also being connected with experiences of other indigenous peoples globally and both resonant and dissonant with the knowledge produced at a national scale about the perceptions and experiences of wider Australian society.

The study's findings demonstrated that Aboriginal people in the Georgina River region face significant challenges and opportunities in successfully adapting to climate change. Through our place-based research methodology we have discovered that there is significant human capacity which, if appropriately resourced and focussed, could help these communities to thrive. Not only are economic or material resources important but social and cultural resources that are grounded in a long history of ecological stewardship and a reciprocal disposition towards the environment are also valuable, indeed arguably invaluable. While not all Aboriginal people in the region are completely engaged with or convinced by the scientific discourse of climate change, they have observed the gradual transformations and shifts in the local ecosystems that such changes bring about. The global phenomenon of climate change is experienced locally, and such experiences are embedded in a rich knowledge of the local environment. This unique constellation of observation and interpretation revealed through the analysis of mixed-method inquiry sheds new light upon the effects of climate change, as well as new possibilities of tackling the problems engendered by global climate change through local praxis.

The UGRB study provides an important baseline for understanding transformations in the complex nexus between local culture and climate, which is shaped and transformed by both global processes and local meanings. The report argues that Aboriginal risk perceptions and understandings of climate change are both important and changing—important because the deep connection to the land provides important insights into the ways that climate change affects local environments, and changing because of the changing relationships between Aboriginal people, traditional knowledge systems, and popular understandings of climate change phenomena. And the argument assumes further importance because of the clear Aboriginal intentionality to remain connected to country despite climate change adversity. In an era of Australian Aboriginal affairs policy, marked by recurring government failure to 'close the gap' of Aboriginal inequity and poverty with the mainstream, the current study's methodological approach and findings point to a particular prospect of a future economic role for small decentralised Aboriginal communities. It is also particularly relevant that non-Aboriginal people are increasingly disinclined to reside in the changing and increasingly uncomfortable climate of the arid-zone 'bush'.

What has been a striking anomaly in the context of climate change impacts and adaptation has been the non-recognition of the crucial importance of identifying, measuring, and documenting important changes and impacts, taking place in the human landscape in response to the unfolding biophysical environmental changes associated with climate change. Such ongoing *psychosocial environmental impact assessment* and monitoring (PSIA) (e.g., [81]) would ensure that such remote region communities are coping with the environmental stressors and challenges of climate change, while documenting important changes and impacts, and adaptation successes and frustrations, as the world fully embraces the challenges and legacy of the Anthropocene. Strategic, and culture and community sensitive, research survey strategies such that reported here, provide an important and complementary indigenous perspective and voice relating to national survey findings reporting on the human dimensions of climate change.

In this paper, we have argued that a mixed methods approach is highly effective for this kind of research as it provides access to, and an emergent clarity about, the changing understandings and sense-makings of a group of Indigenous Australians in ways that might be otherwise inaccessible or overlooked. Both biophysical and socio-cultural transformations are underfoot in the 21st century, and it is imperative that further interdisciplinary cross-cultural research be undertaken into the ways that these transformations are both viewed and acted upon in the interests of the nation.

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